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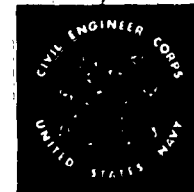
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Project NY 013 02A-5  
Final Technical Memorandum M-062

EVALUATION OF AN EXPERIMENTAL TOBOGGAN

13 July 1953



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U.S. Naval Civil Engineering Research and Evaluation Laboratory,  
Port Hueneme, California

Project NY 013 02A-5  
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# EVALUATION OF AN EXPERIMENTAL TOBOGGAN

13 July 1953

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## SUMMARY

A steel-framed toboggan with V-shaped runners, similar to a toboggan tested at the Arctic Test Station, Point Barrow, Alaska, during the winters of 1950-1951 and 1951-1952, was evaluated at Port Hueneme, California.

The toboggan was fabricated from a design that facilitates economic production in quantity by any reputable fabricator. The tests proved it to be generally satisfactory for hauling light cargo up to a total load of approximately 10 tons. As a result of the evaluation studies, however, the toboggan was redesigned; and it was recommended that the redesigned toboggan be declared a standard cargo toboggan.

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## INTRODUCTION

A need exists in arctic regions for a carrier of light cargo that can be loaded easily without mechanical equipment and will track well when towed in a tractor train. To satisfy this need, the Bureau of Yards and Docks authorized the development and evaluation of an experimental toboggan under Project NY 013 02A-5.<sup>1</sup>

The earliest development under this program was an experimental toboggan-sled with box runners which was tested at Camp Hale, Colorado, during the winter of 1949-1950.<sup>2</sup> This toboggan-sled, along with a toboggan with V-shaped runners, was evaluated again at the Arctic Test Station, Point Barrow, Alaska, during the winters of 1950-1951 and 1951-1952.<sup>3,4</sup>

To correct the deficiencies discovered in these models and to obtain a toboggan that could be produced readily by any steel fabricator, a contract was let the Callahan Engineering Company, Los Angeles, California, for the production design and the fabrication of a prototype.

This technical memorandum includes the evaluation of the prototype designed and fabricated by the Callahan Company. Tests were made to determine the adequacy of the structural framing, back-up plates and rollers, lashing rings, towing-hitch connections, and emergency locker.

## DESCRIPTION OF THE TOBOGGAN

The toboggan is 8 ft wide and 20 ft long. Channel sections made from two 2 by 2-1/2 by 3/8 in. angles, form the side, front, and rear members of the welded steel frame. These built-up channels were substituted for the 4-in. ship channels specified by the Callahan design because the ship channels were not available.

A 3-in. I-beam composed of 7.5-lb-per-ft steel is used as a longitudinal center rib. A diamond-shaped pattern of 3-in. channel sections, between the center rib and the side members, completes the structural frame.

One-inch steel open grating on top of the framing members forms the bed of the toboggan. To contain the load, 2-1/2 by 2-1/2 by 1/4 in. angles are welded to the top flanges of the side members. Lashing rings on the sides, front, and rear provide a means of fastening the load to the toboggan.

On the rear of the toboggan are a pair of rollers (to facilitate the loading of tractors and other vehicles when the toboggan is used as a recovery unit), a hitch, and a back-up plate.

The front of the toboggan is curved upward on a radius of 8 ft beginning at a point 15 ft from the rear end. An emergency locker is mounted on the curved portion of the toboggan.

The bottom of the toboggan is composed of 1/4-in. steel plate to which the framing members are welded. Two V-shaped runners, each formed from two 4 by 4 by 3/8 in. angles, are welded to the bottom plate.

A 1-1/8-in. coil-proof chain bridle, connected to pad-eyes on the bow of the toboggan and provided with a towing ring, furnishes a means for pulling the toboggan. The weight of the toboggan, including the chain bridle and emergency locker, is 5700 pounds.

This toboggan differs from the previous ones in these respects:

1. Side, front, and rear framing members were increased from 3-in. to 4-in. ship channels (built-up 4-in. channels were used in the prototype tested).
2. A diamond-shaped framework, stiffer than those used on earlier models, was used for the structural frame.
3. Back-up plates and rollers were added at the rear of the toboggan.
4. An emergency locker was provided.
5. Angles were added to the side members to help contain the load.
6. The bottom plate was increased in thickness from 3/16 to 1/4 in.

#### EVALUATION FACILITIES

The toboggan was trail-tested at two sites. The first of these, the U.S. Naval Advanced Base Depot, Port Hueneme, California, has an even terrain, and the soil is a fine, loose beach sand. The second,

the Rose Valley Test Site, located approximately 30 miles northwest of the U.S. Naval Advanced Base Depot, has a rolling terrain similar to that at Point Barrow, Alaska. At this site, the soil is hard clay over shale, with shale and small boulders frequently exposed.

### EVALUATION PROCEDURE

Since similar toboggans were tested during three winter test seasons at arctic sites, the experimental toboggan was not evaluated under arctic conditions. The testing procedure was designed to determine the structural rigidity of the frame, the adequacy of the towing pad-eyes and rear hitch, the suitability of the roller assembly, and the usefulness of the lashing rings and side angles, areas in which deficiencies were noted in previous prototypes.

The performance of the toboggan was first tested in sand with a load consisting of fifty 55-gal. drums, arranged in five rows, ten drums pyramided in each row, as shown in Fig. 1. Forty of the drums were filled with water to give a total load of approximately 10 tons. The prime mover used in the first half of this testing was an HD-20 Allis-Chalmers tractor equipped with torque-converter drive. A dynamometer (electric strain-gage type) measured the drawbar pull required to tow the toboggan. The toboggan was towed over even terrain, in a 180 degree turn, over berms formed by back-dumping from trucks, and over a natural bank. In addition, the toboggan was towed backward by means of the rear hitch and a 3/4-in. wire-rope sling. In the second half of the testing, a D-8 Caterpillar tractor was used to haul the toboggan over the same course, but no dynamometer readings were taken. During these tests, the load was secured to the toboggan by means of a cargo net and a rope woven through the net and the lashing rings. This testing was accomplished in approximately 4 hours.

Upon completion of the tests in sandy terrain, the toboggan was unloaded and moved to the Rose Valley Test Site. There it was reloaded with forty 55-gal. drums, filled with water and arranged in four rows, ten drums pyramided in each row. The load was secured to the toboggan by means of chains and chain binders, as shown in Fig. 2. The toboggan was towed by a D-8 Caterpillar tractor over a trail that included rolling, uneven terrain; thick mesquite; and steep banks as high as 12 ft. Towing tests were continued for a total of 16 hours under these conditions.

During these tests, the behavior of the toboggan under load, the effectiveness of the lashing arrangement, the tracking ability, and the adequacy of the towing-hitch assembly were observed.



To determine the effectiveness of the roller assembly for recovery purposes, the load of water drums was removed; and a tractor-type swing crane was loaded on to the toboggan by being driven under its own power over the rear rollers.

## RESULTS AND OBSERVATIONS

### Tests at U.S. Naval Advanced Base Depot

No difficulty was encountered in securing the load to the toboggan with a cargo net and rope, and the load secured in this manner did not shift during the trail test. The chain bridle, towing ring, and pad-eyes showed no sign of distress.

Dynamometer readings varied from a minimum of 13,000-lb to a maximum of 33,000-lb drawbar pull, the average drawbar pull being 16,000 lb. The minimum reading was obtained during a straight pull on level, even ground, the maximum during a turn of 75-ft radius when most of the strain was on one side of the chain bridle. The HD-20 tractor was driven in low-speed range at an average speed of 1 ft per sec. The maximum speed attained by the tractor was 3 ft per sec; however, this speed could be maintained only for a few feet in high-speed range.

On flat trails, sand piled up in front of the toboggan so that a drawbar pull of approximately 25,000 lb was needed to pull the toboggan.

When towed over a side hill and up a 4-ft high bank with a 2-1/2 to 1 slope, the toboggan did not appear to deform. The toboggan was heavy enough to level rough terrain and the tops of banks in loose sand (Fig. 3).

The toboggan was towed backward a distance of 15 ft. During this pull, sand piled up over the back-up plate to a height of 12 in., as shown in Fig. 4.

No distress was observed when the toboggan was pulled by the D-8 tractor from a standing position on hard ground at an angle 80 degrees to the longitudinal axis, with all the strain on one chain of the bridle.

The D-8 tractor was able to pull the loaded toboggan in second gear with 18 in. of sand piled in front of the toboggan, but it could not pull the toboggan in third gear for any significant distance.

No deformation of the toboggan was noted when it was towed over the edge of a bank or along the side of a berm, even though at times the toboggan was supported only on the sides or on the front and rear (Fig. 5). With the D-8 tractor, the toboggan was towed backward a distance of 45-ft, during which time the sand was piled ~~2 ft~~ above the toboggan bed.

It was observed that the smallest turning radius obtainable with either tractor under these conditions was 75 ft. The toboggan, however, could be turned in a smaller radius if the tractor were unhooked, maneuvered into a different position, and then hooked again to the bridle.

Upon conclusion of these tests, no evidence of damage to the toboggan could be found.

#### Tests at Rose Valley Test Site

These trial tests demonstrated that the load was not securely held by the chains and chain binders (see Fig. 6). The pitching motion of the toboggan on hard, uneven terrain caused the drums to shift, making it necessary to stop the test and rearrange the load.

Dynamometer readings were not taken on the drawbar pulls. Usually the D-8 tractor pulled the toboggan in second gear, but first gear was required on pulls up steep banks (1 to 1 slope). There was no apparent distortion of the toboggan even when it was supported only on the sides, or front and rear, or when overhanging a bank.

First gear was required to pull the toboggan through a muddy ravine, and, on one occasion, the tractor was stuck when mud piled in front of the toboggan. In an attempt to break the toboggan loose, the link that connected the bridle chain to the pad-eye on the left side of the toboggan was broken. The link was replaced with a shackle, and the test continued.

The toboggan, riding on the runners on the hard surface at Rose Valley, it tracked well but again was difficult to maneuver (see Fig. 7).

To check the effectiveness of the roller assembly, the drums were unloaded and an International TD-9 tractor, with Austin-Western Swing Crane attached, was run over the rollers under its own power. This 19,000-lb tractor has no cleats on its tracks. The tractor could be

loaded only by using a running start; it lost traction and would not load when attempts were made to move it aboard the toboggan slowly. No damage to the rollers, back-up plate, or steel grating was noted. Although the tractor did not appear to damage the rollers, the left roller did not turn freely except under load. Before starting the loading tests, it was necessary to clean the rollers, which had become frozen with dirt and mud during the trail tests.

Upon the conclusion of the trail tests at Rose Valley, the toboggan was examined for permanent deformation. It was found that there was a longitudinal bow of 1-3/4 in. measured along the 15-ft bed (Fig. 8). The runners were also bowed. The bottom plate was dished and distorted around the framing members so that the pattern of the members could be seen (Fig. 9).

During these trail tests the covers of the emergency locker were broken. The covers had overhanging edges that caught on the heavy brush. The towing ring on the chain bridle was distorted, and it was estimated that the bridle would have failed in 16 additional hours of trail testing at Rose Valley. In addition, the washers which hold the lashing rings in position were bent.

## CONCLUSIONS

The toboggan designed by the Callahan Engineering Company is structurally adequate. Although it was permanently deformed by the severe tests at Rose Valley, it did not deflect an objectional amount when traversing rough terrain with consequent shifting of the load, a weakness in previous models. The 4-in. ship-channel sections specified for the side, front and rear main framing members usually are not stocked by steel supply companies, and premium price must be paid for this type of section when it is available.

The towing pad-eyes and rear hitch gave no evidence of distress. The towing ring which was distorted and the connecting link which was broken are adequate for normal usage. The roller assembly will freeze in many kinds of terrain because soil, snow, and ice lodge between the roller and back-up plate. The rollers cannot be readily cleaned. The lashing rings are adequate, but the washers which retain them will be bent and soon lost, with consequent loss of the ring. The emergency locker covers were ripped and broken because the overhanging edges on front and side catch on brush.

## REDESIGN

The evaluation studies demonstrated the need for modification of the Callahan Engineering Company's design, and the following changes were made:

1. The main frame members on the sides, front, and rear were changed from 4-in. ship-channel sections to 7-in. standard-channel sections weighing 14.75 lb per foot. The standard-channel sections are readily available.
2. The 2-1/2 by 2-1/2 by 1/4 in. angles welded to the top of the side frame members were eliminated since the 7-in. channel provides a containing side 3-in. above the toboggan bed.
3. The lashing rings were replaced with rings made from round bar stock welded directly to the toboggan.
4. The roller assembly and back-up plate were replaced with a half section of 4-in. standard-weight pipe welded to the rear channel.
5. The pad-eye plate was changed from a 3-piece built-up section to a 1-in. single plate. The shackle joining the bridle chain to the pad-eye did not bear upon the top and bottom plates included in the Callahan Engineering Company's design for the pad-eye plates. Therefore, these plates were superfluous.
6. The emergency locker covers were made smaller than the overall locker dimensions to eliminate catching on brush or other objects.
7. Two hasps have been provided on each locker cover to prevent curling of the covers.

## RECOMMENDATION

It is recommended that the redesigned toboggan be declared a standard cargo toboggan.

## REFERENCES

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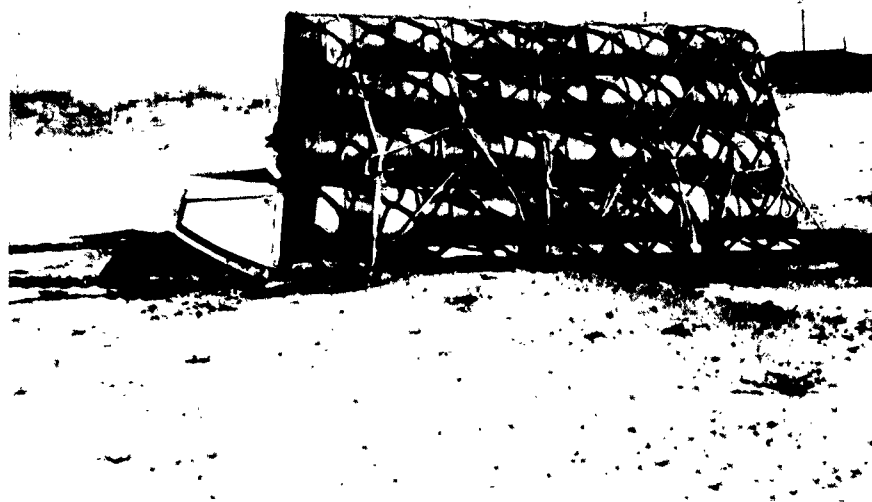


Figure 1. Toboggan with 10-ton load secured with cargo net and ropes, on sandy site at Port Hueneme, California.



Figure 2. Toboggan being subjected to racking action at Rose Valley Test Site on hard, uneven terrain, the load secured by chains and chain binders.



Figure 3. Uneven soft sand terrain leveled by the weight of the towed toboggan.



Figure 4. Toboggan being pulled backward in soft sand.



Figure 5. Toboggan being pulled over the edge of a berm in sandy soil. The toboggan did not distort, and the load did not shift.



Figure 6. Shifting of load secured with chain rigging during trail tests at Rose Valley.





Figure 7. Toboggan tracks in hard, uneven terrain at Rose Valley Test Site.



Figure 8. Measurement of 1-3/4 in. bow in the bottom plate of the toboggan at completion of trail tests.



**Figure 9.** Steel bottom plate upon completion of trail tests, showing dishing around framing members.